

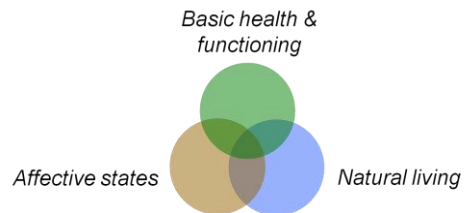
Improved Care and Management through Increased Knowledge of Dairy Cattle Behavior

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Why consider behavior?



Use of behavior of the dairy cow to show us...

- When she is comfortable
- What environment and feed she prefers
- When she is sick



What are we going to look at today?

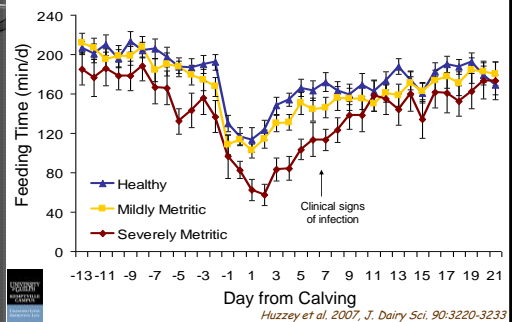
- Interactions of behavior with health, production, and welfare
- Design and management of feeding and lying areas for dairy cattle
 - Free access to balanced ration
 - Adequate rest



Can cows get to the feed provided to them?



Cows with severe metritis spent less time feeding per day in the week prior to calving

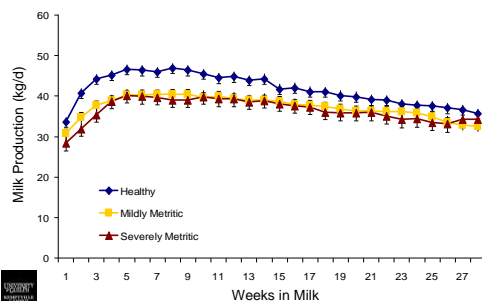


Relationships between feeding time (min/d) and DMI (kg/d) are strong, particularly for severely metritic cows post partum

Health Category	R ²	
	PRE (d -14 to d -1)	POST (d 1 to d 21)
Healthy (n=23)	0.36	0.67
Mildly metritic (n=27)	0.41	0.69
Severely metritic (n=12)	0.64	0.81

Huzzey et al. 2007, J. Dairy Sci. 90:3220-3233

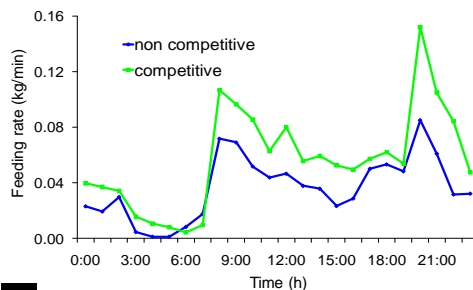
Result...more milk!



Huzzey et al. 2007, J. Dairy Sci. 90:3220-3233

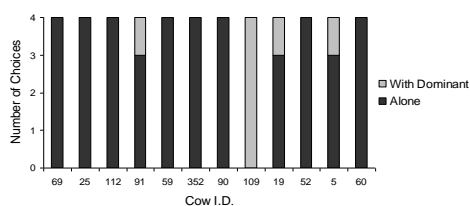
What prevents cows from accessing the feed bunk?

Competition = Higher feeding rate



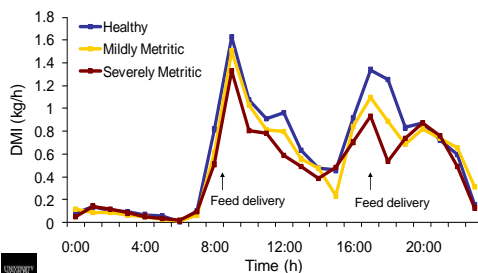
Hosseinkhani et al. 2008, J. Dairy Sci. 91:1115-1121

Subordinate cows given choice to trade-off feed quality with feeding alone or next to dominant cow



Rioja-Lang et al. 2009, Appl. Anim. Beh. Sci. 117:159-164

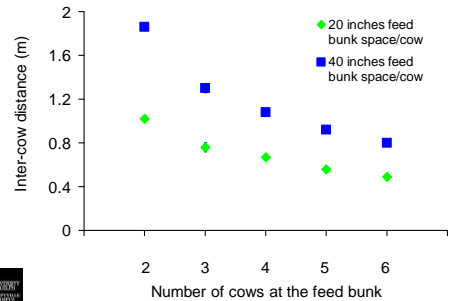
Sick cows eat less during peak feeding times



Huzzey et al. 2007, J. Dairy Sci. 90: 3220-3233

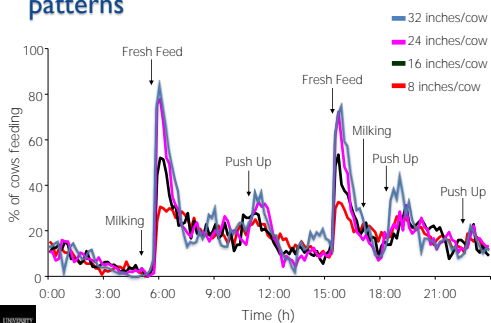
What can be done to reduce feed bunk competition?

Do cows like to be close to one another?



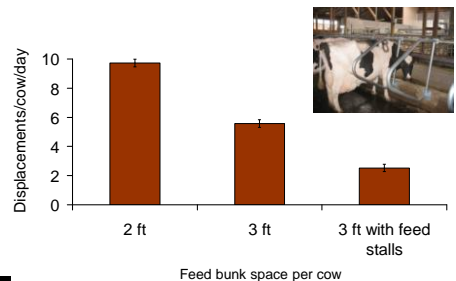
DeVries et al., 2004, J. Dairy Sci., 87:1432-1438

Stocking density and diurnal attendance patterns



Huzzey et al., 2006, J. Dairy Sci., 89:126-133

More space + physical barrier = less competition



DeVries and von Keyserlingk, 2006, J. Dairy Sci., 89:3522-3531

How do cows eat the feed provided to them?

Eating behavior and rumen fermentation

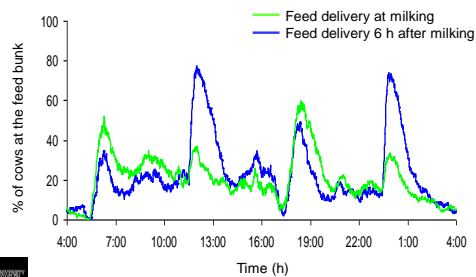
- Fewer, larger meals
 - Larger declines in rumen pH (Allen, 1997)
 - Increased risk of ruminal acidosis
- Longer feeding times, slower feeding rate
 - Increased salivary secretion (Beauchemin et al., 2008)
 - Decreased risk of ruminal acidosis

Feed sorting:

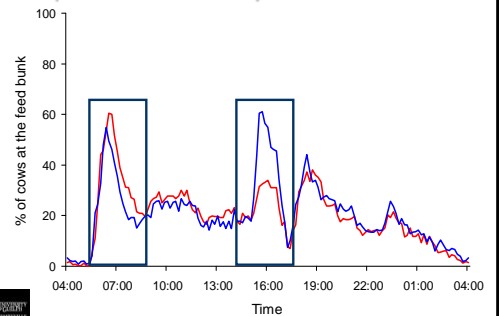
- Some cows
 - Have large meals with a higher proportion of grain concentrate and less forage than predicted
 - Risk of sub-acute ruminal acidosis (DeVries et al., 2008)
- Other cows
 - Poor bunk access
 - Competition
 - Not meet nutrient requirements?

Besides feed bunk competition...
what other factors affect the way cows eat?

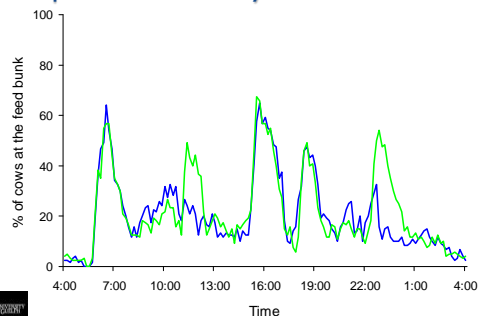
What stimulates cows to get up and feed?



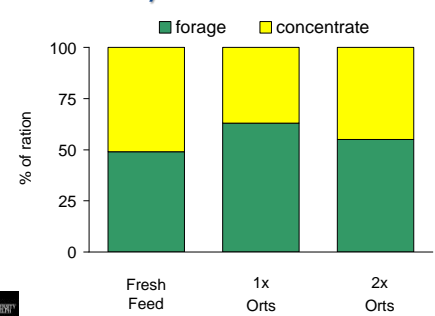
Increased feed bunk activity with more frequent feed delivery



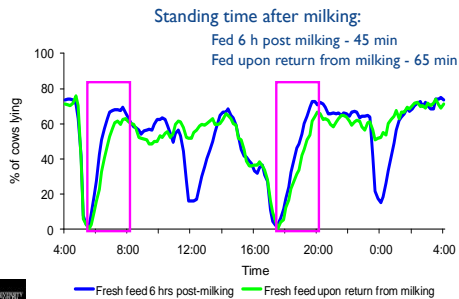
Increased feed bunk activity with more frequent feed delivery



Less feed sorting with twice per day feed delivery



Does it matter when we provide feed to cows?



DeVries and von Keyserlingk, 2005; J. Dairy Sci. 88: 3553-3562

Standing time after milking is associated with the risk of subclinical mastitis!

- Relative to lying down with 40 min of milking:
 - Risk of infection tended to go **DOWN** if cows lie down between 40 and 60 min after milking
 - Risk of infection went **UP** if cows lie down > 60-90 min after milking

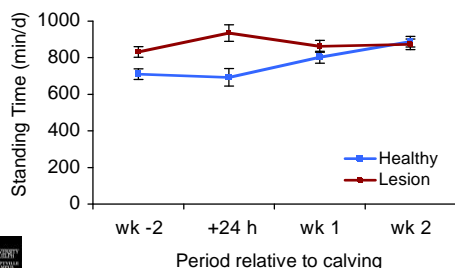
DeVries et al. 2010, J. Dairy Sci. 93:1987-1997

Do cows have an appropriate place to rest?

Lying stall design and management

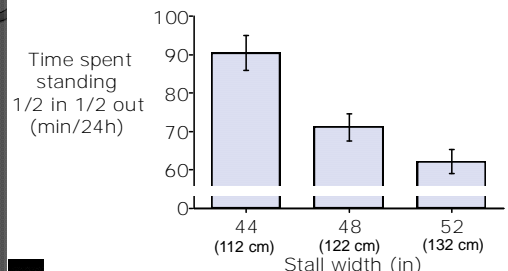
- Tie stall or free stall
 - Same concepts apply
 - Enough space to rise and rest
 - Comfortable surface to lay down on
- ...these factors can have direct impact on cow health!

Cows that develop lesions and ulcers in mid-lactation stand longer during the 2 wk before and 24 h after calving ...



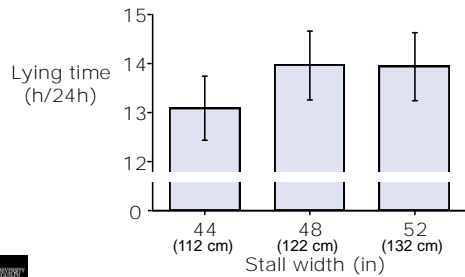
Proudfoot et al. 2010, J. Dairy Sci. 93:3970-3978

Wider stalls = less 1/2 in 1/2 out



Tucker et al., 2004, J. Dairy Sci. 87: 1208-1216

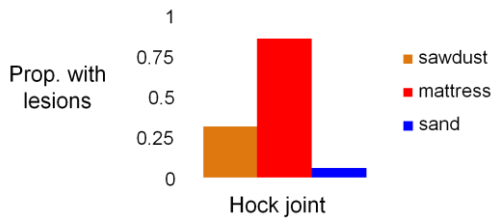
Wider stalls = longer lying times



Tucker et al., 2004, J. Dairy Sci. 87: 1208-1216

What about the lying surface?

Other health issues with bedding... hock injuries



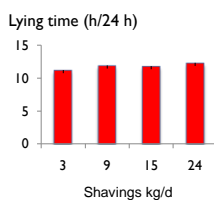
Weary & Taszkun, 2000, J. Dairy Sci. 83: 697-702

Adding bedding to free-stall mattresses also improves lying times



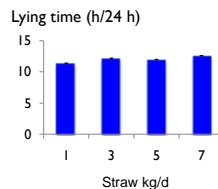
Tucker & Weary, 2004, J. Dairy Sci. 87: 2889-2895

Lying time increased when cows housed in tie stalls were provided with more shavings



Tucker et al. 2009, J. Dairy Sci. 92:2684-2690

Lying time increased when cows housed in tie stalls were provided with more straw bedding



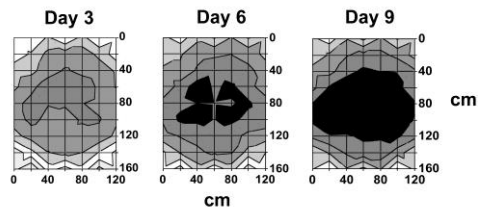
Tucker et al. 2009, J. Dairy Sci. 92:2684-2690

Maintenance of deep-bedded stalls can also affect stall usage



Bedding in deep-bedded stalls

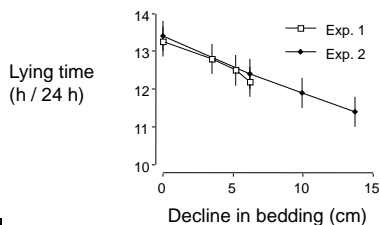
■ 8-10 cm ■ 6-8 cm ■ 4-6 cm ■ 2-4 cm □ 0-2 cm □ (-2)-0 cm □ (-4)-(-2)cm



Days after sand bedding was added and leveled

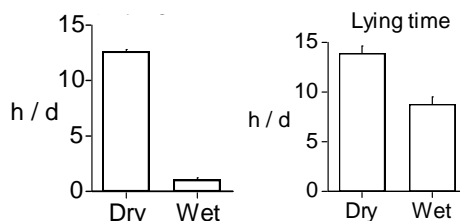
Drissler et al., 2005, J. Dairy Sci. 88: 2381-2387

Cows spend less time lying down in stalls that have not been maintained



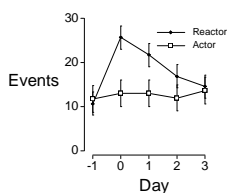
Drissler et al., 2005, J. Dairy Sci. 88: 2381-2387

Dry lying areas = longer lying times



Fregonesi et al., 2007, J. Dairy Sci. 90: 5468-5472

When regrouped, the social behavior in the group changes



von Keyserlingk et al. 2008, J. Dairy Sci. 91:1011-1016

Cows also spend less time eating and lying down on the day after regrouping and produce 4 kg (8.5 lbs) less milk



von Keyserlingk et al. 2008, J. Dairy Sci. 91:1011-1016

Take home messages...

- Knowledge of cow behaviour can be used to identify:
 - Cows at risk or experiencing illness
 - Feeding management strategies that allow cows to access and consume the feed you provide to them
 - Adequate space, reduced competition
 - Feed fresh feed in front of cows



Take home messages...

- Knowledge of cow behaviour can be used to identify:
 - Resting areas that promote long lying times and cow health
 - Less restrictive stall configurations
 - More use and maintenance of bedding
 - Management strategies to reduce stress and improve production



Thank you to Drs. Marina von Keyserlingk and Dan Weary of the UBC Animal Welfare Program, as well as NSERC, Dairy Farmers of Canada, Agriculture and Agri-Food Canada, Westgen, and Investment Agriculture Foundation of British Columbia for their financial support of this research.



IMPROVED CARE AND MANAGEMENT THROUGH INCREASED KNOWLEDGE OF DAIRY CATTLE BEHAVIOR

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²Animal Welfare Program, The University of British Columbia

INTRODUCTION

Producers invest significant amounts of money in constructing housing for dairy cattle, with the aim of providing a comfortable environment that will not only meet the physiological needs of the cows, but also their behavioral needs. This environment should ensure adequate rest and free access to an appropriate, well-balanced diet. Despite these aims, housing systems do not always function well from the perspective of the cow; poorly designed, managed, and maintained facilities can cause injuries, increase the risk of disease, and increase competition among herd mates for access to feed and lying space. This proceedings chapter with review empirical work focused on using knowledge of cow behavior to show when she is sick, when she comfortable, and what environments and feed she prefers. In particular, we will review the lying and feeding areas we provide to dairy cows, and show how these can be better designed and managed to improve cow comfort, prevent health problems, and improve productivity.

INTERACTION OF BEHAVIOR AND HEALTH ISSUES

There is mounting evidence that measures of behavior can be used to predict and identify health and welfare concerns in dairy cattle (von Keyserlingk et al., 2009). Recent publications have reported on changes in behavior associated with various health issues, including metabolic and infectious disease, lameness, and mastitis; these health issues not only pose immediate welfare concerns to dairy cattle, but can also affect efficiency and productivity.

Feeding Behavior and Cow Health

During the transition period dairy cows are vulnerable to metabolic and infectious diseases. Researchers have shown that cows diagnosed with acute metritis after calving spent less time feeding during the prepartum period (d -12 to -2 prior to calving; Urton et al., 2005). In a follow-up study, Huzzey et al. (2007) monitored individual feeding time and dry matter intake (DMI) using a larger sample size of cows and also monitored individual DMI. Cows diagnosed with severe metritis 7-9 d postpartum consumed less feed and spent less time at the feed bunk during the 2 wk period before calving, nearly 3 wk before the observation of clinical signs of infection. Moreover, during the week before calving cows were 1.7 times more likely to be diagnosed with severe metritis for every 10 min decrease in feeding time. For every 1 kg decrease in DMI during this period, cows were also nearly 3 times more likely to be diagnosed with severe metritis. In that study, the decreases in feed intake contributed to decreased milk

production; mildly and severely metritic cows produced 5.7 and 8.3 kg less milk per day compared to healthy cows during the first 3 weeks after calving.

Recent work showed similar findings with cows that developed subclinical ketosis (SCK; Goldhawk et al., 2009). Cows diagnosed with SCK during the week after calving showed differences in feeding behavior and DMI as early as 1 wk prior to calving. Not only was DMI reduced pre partum, but SCK animals also initiated fewer displacements at the feed bunk during the week before calving. This is similar to the findings of Huzzey et al. (2007) where cows diagnosed with metritis engaged in fewer aggressive interactions at the feedbunk during peak feeding periods, resulting in lower DMI. These results indicate that the risk of transition cow diseases, such as metritis and SCK, may be reduced by utilizing management and housing practices that allow for increased feed bunk access.

Management practices that cause adult dairy cattle to eat fewer and larger meals more quickly have been associated with an increased incidence of sub-acute ruminal acidosis (Krause and Oetzel, 2006). The reason for this risk is that ruminal pH declines following meals, and the rate of pH decline increases as meal size increases and as dietary effective fiber concentration decreases (Allen, 1997). Further, as cows spend less overall time feeding, and increase their rate of feed consumption, daily salivary secretion is reduced (Beauchemin et al., 2008), decreasing the buffering capacity of the rumen and reducing rumen pH. Alternatively, when cows slow down their rate of DM consumption, and have more frequent, smaller meals, throughout the day, rumen buffering is maximized, large within-day depressions in pH are avoided, and the risk of sub-acute ruminal acidosis is decreased. Another feeding behavior linked to sub-acute ruminal acidosis is the preferential sorting of a total mixed ration (TMR). The sorting of TMR by dairy cows can result in the ration actually consumed by cows being greater in fermentable carbohydrates than intended and lesser in effective fiber, thereby increasing the risk of sub-acute ruminal acidosis (DeVries et al., 2008). Sorting of a TMR can also reduce the nutritive value of the TMR remaining in the feed bunk, particularly in the later hours past the time of feed delivery (DeVries et al., 2005; Hosseinkhani et al., 2008). This may be detrimental for those cows that do not have access to feed at the time when it is delivered. In such cases, these cows may not be able to maintain adequate nutrient intake to maintain high levels of milk production (Krause and Oetzel, 2006) and maintain adequate nutrient intake to allow for maximum milk production.

Lying and Standing Behavior and Cow Health

In addition to feeding related behaviors, standing and lying behavior patterns of lactating cows may be related to health concerns. One such behavior is the amount of time cows spend standing following milking. The common belief is that the longer the animal stands after milking, the lower the risk for bacterial penetration of the teat orifice when the cow eventually lies down, and thus lower risk of mastitis. Availability of fresh feed following the return from milking has been used to encourage cows to remain standing (while feeding) rather than to lie down. Researchers have shown that the

presence of fresh feed in the bunk encourages longer post-milking standing times (DeVries and von Keyserlingk, 2005). DeVries et al. (2010) recently found that the provision of feed around milking time resulted in the longest post-milking standing times. Further, this was the first study to document how post-milking standing time relates to the risk of subclinical infection; cows that lay down, on average, for the first time 40 to 60 min after milking had lower odds of a new subclinical infection caused by environmental bacteria compared to cows that lay down within 40 min after milking. These results suggest that management practices that discourage cows from lying down immediately after milking will help decrease the risk of subclinical mastitis.

Another health concern that has been related to the standing and lying behavior of dairy cattle is lameness. Proudfoot et al. (2010) demonstrated that cows that developed sole lesions and ulcers in mid-lactation stood for longer periods of time during the 2 weeks prior and 24 hour after calving compared to those cows that retained good hoof health during that time period. Interestingly, these researchers were able to determine where those cows that developed sole lesions and ulcers were spending more time standing; these cows spent more time “perching” half way in the stall compared to healthy cows before calving. This result suggests that changes in housing design and management strategies to minimize such behavioral patterns may reduce the risk of lameness.

IMPROVING STALL DESIGN AND MANAGEMENT

Most research on stall design for cattle has concentrated on two aspects: the surface cows lie down upon, and how the freestall is configured. Cows clearly prefer softer lying surfaces with more bedding, and spend more time lying down in well-bedded dry stalls (Tucker and Weary, 2004; Fregonesi et al. 2007). However, the lying surface can also affect udder health. Use of organic bedding material can increase the risk of some types of mastitis and many studies have shown the advantages to cows of using sand or other inorganic bedding as a way of reducing the growth of bacteria associated with environmental mastitis (e.g. Zdanowicz et al., 2004). There is some evidence that cows prefer lying down on straw rather than sand (Manninen et al., 2002), but this can be altered with greater experience of sand (Norrington et al., 2008). Furthermore, the reduced risk of mastitis or lameness (Cook, 2003; Espejo et al. 2006; Norring et al., 2008) with sand bedding may compensate for the reduced preference.

The configuration of freestalls (stall size, position of neck rail, etc.) can also have a major effect on cow comfort (Tucker et al., 2004, 2005, 2006). In addition to stall width, neck-rail placement is important for managing standing behavior. Both the height of the neckrail and its distance from the curb affect how cows use the stall for standing (Tucker et al., 2005); more restrictive neck-rail placements (lower and closer to the rear of the stall) prevent cows from standing fully in the stall and in turn increases the time cows spend either perching in the stall or on concrete flooring elsewhere in the barn, increasing the risk of lameness.

Stalls should provide a clean, comfortable area for cows to lie down. However, cows often stand in the stalls increasing the risk of feces falling onto the lying area. The common response by barn designers has been to make the stalls more restrictive, forcing cows back into the concrete alley. Keeping cows from using the stalls will keep the stalls clean - both narrow freestalls and the more restrictive neckrail placements reduce the amount of fecal matter that ends up in the stall. However, stall cleanliness alone is a poor measure of stall design. Freestalls that are more comfortable have higher occupancy rates and are therefore most likely to contain feces.

IMPROVING FEED BUNK DESIGN AND MANAGEMENT

Feed Bunk Design

There are several aspects of the feeding environment that have the potential to influence the ability of cows to access feed, including the amount of available feed bunk space per animal and the physical design of the feeding area. Recent observations have suggested that at the current industry standard of 24 inches of feeding space per cow not all animals can access feed at the same time (DeVries et al., 2003). As social animals, cattle tend to synchronize their behavior, including a strong desire to access the feed bunk as a group. When space is reduced, this behavior increases competition for access when, for example, you deliver fresh feed and cows are highly motivated to head for the bunk. As available feed bunk space is reduced, competition increases and feed access decreases (DeVries et al., 2004; Huzzey et al., 2006). Hosseinkhani et al. (2008) recently demonstrated that competition at the feed bunk dramatically increased the feeding rate at which cows feed throughout the day. These researchers also found that competitively-fed cows have fewer meals per day, which tend to be larger and longer. In the study by Hosseinkhani et al. (2008) it was also found that competition changed the distribution of DMI over the course of the day, resulting in higher intakes during the later hours after feed delivery after much of the feed sorting had already occurred. Thus, increased competition promotes feeding behavior that forces subordinate cows to consume more of their feed after the dominant cows have sorted the TMR. These results suggest that increased competition at the feed bunk promotes feeding behavior patterns that will likely increase the between-cow variation in composition of TMR consumed and the risk of sub-acute ruminal acidosis. Providing more space than the current industry norm has been shown to improve feed bunk access; this increases feeding times and decreases competition, with subordinate cows showing the greatest responses (DeVries et al., 2004; Huzzey et al., 2006). This change will help reduce the variation in the composition of feed cows consume as subordinate cows will be able to access the feed prior to it being sorted through by those dominant cows.

In addition to increasing the amount of available feed bunk space, competition for feed can also be reduced through design of the feeding area. Researchers have shown that a headlock system greatly reduces competition at the feed bunk compared with a post-and-rail system (Endres et al., 2005; Huzzey et al., 2006). Another option to reduce competition is the use of partitions (feed stalls) between the bodies of adjacent cows at

the feed bunk. DeVries and von Keyserlingk (2006) demonstrated that feed stalls resulted in increased feeding time and decreased competition, particularly for subordinate cows. Their results suggest feed stalls provide additional protection for feeding cows, and improved access to feed beyond that provided by simply increasing the amount of space per animal.

Feed Bunk Management

One of the most common feeding management practices believed to stimulate feeding activity is feed push-up. When fed a TMR, dairy cows have a natural tendency to continually sort through the feed and toss it forward, where it is no longer within reach. This is particularly problematic when feed is delivered via a feed alley and, thus, producers commonly push the feed closer to the cows in between feedings to ensure that cows have continuous feed access. In an observational study, Menzi and Chase (1994) noted that the number of cows feeding increased after feed push-up; however they concluded that feed push-ups had minor and brief effects in comparison to milking on the feed bunk attendance. In a more recent study, we tested the stimulatory effect of feed push-up by increasing the number of push-ups during the late evening and early morning (DeVries et al., 2003). In that study we found that the addition of extra feed push-ups in the early morning hours did little to increase feeding activity. However, push-up does play a vital role in ensuring that feed is accessible when cows want to eat.

For group-housed dairy cattle, the act of feed delivery acts as the primary stimulus by which dairy cows are attracted to the feed bunk (DeVries and von Keyserlingk, 2005). Not surprisingly, in a study by DeVries et al. (2005) it was demonstrated that frequency of feed delivery influences the ability of cows to access feed, particularly fresh feed. More frequent feed delivery not only results in cows spending more time at the feed bunk, but also results in a more even distribution of feeding time over the course of the day. Interestingly, subordinate cows were not displaced as frequently when fed more often, indicating that these cows would have greater access to feed, particularly fresh feed, when the frequency of feed delivery is high. It was also shown in that study that increasing the frequency of feed delivery from 1x to 2x per day reduces the amount of feed sorting. These results suggest that higher frequencies of feed delivery alter feeding behavior and that, in turn, reduces the variation in diet quality consumed by the cows within the group. Further, frequent feed delivery promotes a more consistent and balanced intake of nutrients over the course of the day, and thus promotes healthier rumen fermentation patterns.

CONCLUSIONS

This review has outlined a few key areas of concern regarding the care and management of dairy cattle, and has shown how scientific research can help address these concerns. For example, new research has shown how indoor housing systems can be made more comfortable for adult cows and how common diseases like subclinical ketosis, metritis, sub-acute ruminal acidosis, mastitis, and lameness can be

better identified and prevented through improvements in the ways cows are housed and managed.

ACKNOWLEDGEMENTS

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